

# Advanced Scientific Computing Program

**Lawrence Livermore National Laboratory**  
**Oak Ridge National Laboratory**  
**Sandia National Laboratory**

**The mission of the Advanced Scientific Computing Program is to develop enabling computational science and mathematics technologies for deployment in next-generation homeland security applications.**

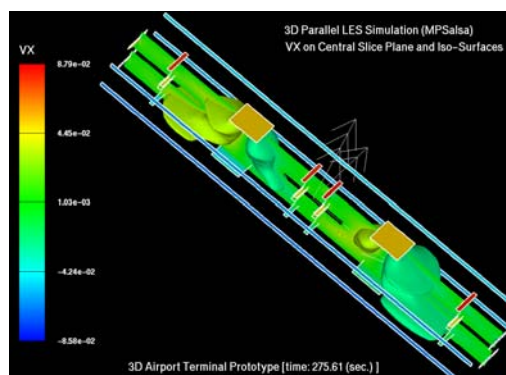
The computational systems we provide are developed with key partners, stakeholders, and end users for the Department of Homeland Security.

This activity is based within the Computing Applications and Research Department of Lawrence Livermore National Laboratory's Computation Directorate. It is one of many activities providing mission-critical technology to DHS under the purview of Livermore's Homeland Security Organization.

## Background

The Advanced Scientific Computing (ASC) Program originated in the Department of Energy's Office of Science as an applied research program at Lawrence Livermore National Laboratory. ASC was transferred to DHS S&T in the legislation creating the new department. That transfer gave DHS immediate access to a world-class team of computer scientists and mathematicians, as well as to the state-of-the-art high performance computing facilities at Lawrence Livermore. ASC has further enhanced its breadth since joining DHS by partnering with Oak Ridge National Laboratory and Sandia National Laboratory.

The goal of the program is to assemble the scientific computing expertise needed to meet the long-term needs of the Department. These needs derive from the diverse mix of operational missions that DHS is home to. Fulfilling them requires mastery of a comparably rich collection of computational science and mathematics specialties, and in its first year ASC has demonstrated its prowess in several key domains.

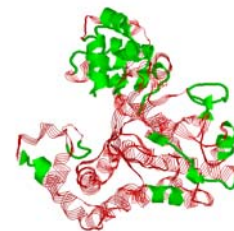


## ASC Strategic Vision

***integrated information and simulation science will provide the foundation for the advancement of science-based threat characterization and response for homeland security***

## Early Achievement

In the bioinformatics arena, ASC has distinguished itself through the development of novel high performance computational approaches for genetic analysis. ASC researchers delivered a ten-fold speedup in DNA sequence alignment with an algorithm that, for the first time, operated on draft DNA sequences. This capability is intrinsic to creating the DNA signatures employed in biodetectors to identify biological pathogens in the environment.



ASC work in information sciences is forging new infrastructure tools to enable the intelligence and law enforcement communities to dynamically integrate and curate heterogeneous databases under a shared, consistent view. This effort is now part of an upcoming demonstration for the Biodefense Knowledge Center, an element of DHS' National Biosecurity Analysis and Countermeasures Center.

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ASC projects in computational fluid dynamics (CFD) are creating enhanced capabilities for modeling transport of air- and waterborne contaminants over multiple length scales of interest to the homeland security community. The Adaptive Dispersion Modeling Project has developed an automated meshing capability based on Livermore and NASA software that has demonstrated a 5000-fold speed-up in CFD problem setup, reducing a one week interactive process to two minutes. This capability is being delivered to Livermore's National Atmospheric Release Advisory Center, a key resource for DHS' Emergency Preparedness and Response Directorate.

In October, 2003, ASC held the Advanced Scientific Computing Requirements Workshop, with participation from DHS, government laboratories, academia, and industry, to develop a comprehensive assessment of advanced computing needs across the DHS mission space. Looked upon as a great success, the workshop permitted the alignment of mission needs with potential solution technologies to feed a strategic vision for the ASC program that will direct its research focus in the coming years.

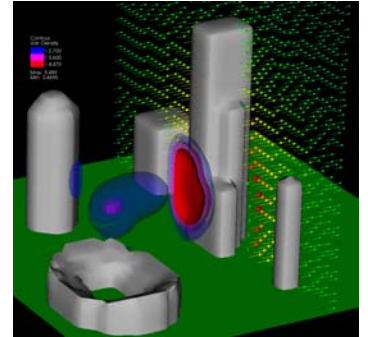


## Key Focus areas

The vision for a successful research program centers on four strategies:

**1. Develop scalable algorithms and software for information management and knowledge discovery to support terrorist threat identification and threat-vulnerability linkage.** The ever increasing amount of dynamically changing multi-modal data dictates the development of algorithms and software that can scale to analyze very large amounts of data.

**2. Develop scalable, integrated simulation analysis capabilities for use in threat assessment, training, scenario planning and incident response.** New algorithms must address the challenge of coupling multiple simulations and data analysis capabilities in order to provide insight and inform decision making for homeland security.



**3. Establish a national program to develop scalable discrete mathematics and uncertainty quantification algorithms to enable large-scale multi-simulation and information analyses with confidence measures.** This program will enable advances in discrete simulation and optimization algorithms that are uniquely needed by DHS to predict, detect, monitor, respond to, and remediate attacks on the nation's infrastructure. Developments in uncertainty quantification will provide decision makers with confidence measures that enable informed, probabilistic risk assessment associated with simulation and information analyses.

**4. Establish a national computing center to support research and development and provide surge capability to DHS operational assets.** This capability will provide resources for DHS R&D and also enable the exploration and evaluation of novel architectures prior to procurement for operational use within DHS.

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